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26 February 1981

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On behalf of all of us in FBIS I wish to express appreciation to our readers who have guided our efforts throughout the years.

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JAPAN REPORT

No. 119

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MILITARY

ASDF BUDGET, MILITARY OPERATIONS PLAN FOR FY 1981

Tokyo JPF AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 3-6

[Text] The Cabinet has approved ¥564,600 million in its FY 1981 (April 1981-March 1982) appropriation and ¥243,400 million in follow-on disbursements for the Air Self-Defense Force (ASDF).

The FY 1981 appropriation represents a 9.8 percent increase over FY 1980. Of it, personnel and food expenditures account for ¥204,300 million (up 5.5 percent), expenditures coming from earlier-authorized follow-on disbursement funds ¥233,200 million (up 16.8 percent), and others ¥127,100 million (up 5 percent). Although a large increase is seen in the expenditures resulting from earlier-authorized funds, the 5 percent rise in the other expenditures covering new projects is to be offset by inflation.

The follow-on disbursement funds total a 45-percent less than the current fiscal year in the absence of orders for F-15 fighters in FY 1981. They comprise ¥14,800 million for treasury obligations in FY 1981 (up 18.4 percent) and ¥228,600 million for obligations in subsequent years (down 46.8 percent). The follow-on disbursement funds boost total funds for appropriation in FY 1982-85 to ¥582,200 million. This figure breaks down ¥271,000 million in FY 1982, ¥204,600 million in FY 1983, ¥105,800 million in FY 1984 and ¥800 million in FY 1985. The ASDF's operations plan in FY 1981, based on this budget, is outlined as following:

1. Organization

(1) The ASDF personnel will be increased by 283 persons over FY 1980 to 51,160 persons (46,523 officers and men and 4,637 civilian employees).

(2) Organizational improvement:

a) A new training squadron will be organized at Tsuiki Air Base to evaluate pilots' skills and train them. The 100-man squadron, placed under the Air Defense Command, will have five T-2s and two T-33As.

b) An air traff c safety control group will be set up around Tachikawa to investigate air and ground accidents and carry out air traffic safety education. It will be placed under the direct command of the State Minister for Defense. Of the requested 70 or so personnel, funds for about 20 have been approved. The ASDF will request the remainder for FY 1982.

c) An ad hoc squadron will be established for the six F-15Js to be acquired in FY 1981.

d) An 18-aircraft F-4EJ squadron will be set up in the 6th Air Wing as the 306th squadron to replace the 205th squadron of F-104Js which will retire. As a result, F-4EJ squadrons will then total six.

e) A communications security group will be set up at the Central Air Communications Squadron in Ichigaya for research on code and secret communications.

2. Major Equipment

(1) Aircraft

Seventeen new aircraft will be procured. They are four E-2C airborne early warning aircraft, two C-130H transports, two F-1 support fighters, six T-2 trainers, one MU-2 rescue aircraft and two V-107A helicopters. Besides them, maintenance instruments, spare engines and training equipment for the F-15 will be acquired.

(2) Information and Communications

One radio-photo transmission system and one ECM (electronic countermeasures) surveillance system will be procured along with two defense microwave circuits and command/control facsimile systems for four air bases.

(3) Radar

One fixed three-dimension radar system and one meteorological radar system will be procured. Research on modernization of the automatic warning/control system will be carried out in cooperation with American experts, at a cost of about ¥360 million, to select a new system and prepare a procurement plan.

(4) Electronic Warfare Equipment

Ten AN/ALE-40 chaff flare dispensers and 12 AN/ALE-41 chaff dispensers will be purchased. The ASDF plans to equip all aircraft with the ALE-40 chaff flare dispensers. The 12 ALE-41s are 11 for F-4EJs and one for a C-1. Six ALE-41s for F-1s have been disapproved along with one ALQ-6 and three ALQ-119s. All of them will be incorporated into the FY 1982 budget request.

(5) Air Base Defense Equipment

Two Tan-SAM short-range surface-to-air missiles for technical training will be procured together with six portable SAMs for Misawa Air Base. Four aircraft shelters will be purchased for Chitose and Misawa bases. Besides, the ASDF will procure 10 sets of runway repairing equipment--six for Chitose and one each for Tsuiki, Hyakuri, Nyutabaru and Naha.

(6) Training Equipment

One M-3D warning/control radar system will be purchased to replace a MAP radar for training at Kozoji. Equipment for Iwojima Island, including power supply facilities, will be prepared along with two sets of air space coordination equipment. For research on the ACMR/1 tactical training/evaluation system, two officers will be dispatched to training facilities of the U.S. Forces.

(7) R&D

Target drones and other equipment will be procured for operational tests of the F-15. Two sets of equipment, one for lengthening the F-4EJ's service life and another for increasing its performance, will be prepared to start the F-4EJ improvement program.

(8) Secrecy Maintenance

One set of facility maintenance and check equipment will be procured for Misawa base together with two maintenance systems and 47 containers.

CSO: 4120

MILITARY

ASDF STUDYING AIM-9L AAM PRODUCTION PROGRAM

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 8,9

[Text]

The ASDF is studying a program for license production and procurement of the AIM-9L air-to-air missile for the F-15J fighter as the government has earmarked ¥5,400 million for purchase of about 170 AIM-9Ls in the FY 1981 budget, on the condition that they will be domestically produced under license. It will select a prime contractor for the AIM-9L production program soon. A promising candidate is Mitsubishi Heavy Industries Ltd. (MHI), which is expected to prepare a setup for the program through a tie-up with Raytheon.

Domestic production of the infrared AIM-9L is designed to solve problems arising from foreign military sales (FMS) procurement from the United States, such as comparatively high cost and delay in delivery dates, and to improve Japan's infrared AAM technology. As for radar homing AAMs, Mitsubishi Electric Corp. (MELCO) has already been engaged in license production of the AIM-7E for the F-4EJ and the AIM-7F for the F-15J.

So far, all of missiles of the AIM-9 series have been procured for the F-86F, F-104J, F-4EJ and F-15J through the FMS system. The AIM-9L and all other AIM-9 series missiles will be subjected to license production.

The guidance & control section (GCS) of the AIM-9L will be released for Japan's license production in the autumn of 1982, although the active optical target detector (AOTD) is unlikely to be released for the time being. Other parts will be subjected to license production for AIM-9Ls to be procured in FY 1981, according to local industry sources.

CSO: 4120

MILITARY

ASDF TO MODIFY VULCAN GUNS FOR AIR BASE DEFENSE

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 p 8

[Text]

The ASDF will modify two 20mm Vulcan machine guns of the F-104J fighter for air base defense in FY 1981, with ¥99.94 million set aside for the program in the budget for the next fiscal year. The modified guns with ground-based turrets will be evaluated and adopted together with the 20mm Vulcan air defense system (VADS) in FY 1982.

Coupled with the Tan-SAM short-range surface-to-air missiles and portable SAMs to be procured from FY 1981, they will strengthen an air base defense setup.

The modification will cover Vulcans of retiring F-104Js to save funds for building up antiaircraft machine guns. Each air base will have 16 machine gun systems and each radar site six to eight. The VADS systems will be installed at seven major air bases, while modified Vulcans will be placed at other bases.

CSO: 4120

MILITARY

ASDF REVISES AIRCRAFT PROCUREMENT PROGRAM

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 6,7

[Text]

The ASDF has revised its aircraft acquisition program as procurement for FY 1981 has been reduced to 17 aircraft from the requested 25 aircraft at intra-government budget negotiations. E-2C, MU-2 and V-107 aircraft have been approved as requested, but F-1, C-130H and T-2 aircraft requests were cuts. The C-130H request, in particular, was reduced to only two aircraft from the requested six. But at least this approval got the C-130 program started. The ASDF's revised aircraft acquisition program is as follows:

F-1 Support Fighter: Procurement in FY 1981 has been reduced to two (from the requested three) with disbursement over three years. The two will be delivered in FY 1983.

E-2C Airborne Early Warning Aircraft: Four aircraft have been approved (as requested) with disbursement over five years. The ASDF will take delivery of two in FY 1984 and another two in FY 1985.

C-130H Tactical Transport: Two have been approved for three-year disbursement. (The original request had covered six--two for delivery in FY 1983 and four in FY 1984--with disbursement over four years.) They will be delivered in FY 1983.

T-2 Trainer: Six of them have been approved. (The original request had covered nine--four for delivery in FY 1983 and five in FY 1984--with four-year disbursement.) Three will be delivered in FY 1983, and another three in FY 1984.

MU-2 Rescue Aircraft: One has been approved (as requested) for delivery in FY 1982 with disbursement over two years.

V-107A Helicopter: Two have been approved (as requested) for delivery in FY 1982 with a two-year disbursement.

*Other two SDF aircraft requests also cut

Aircraft procurement has also been cut from the requested 16 to 14 for the Ground Self-Defense Force (GSDF) and from 17 to 12 for the Maritime Self-Defense Force (MSDF). Their revised aircraft acquisition programs are as follows:

GSDF: Eight OH-6Ds in FY 1982, five HU-1Hs in FY 1982 and one LR-1 in FY 1982.

MSDF: Four TC-90s in FY 1982, one KM-2s in FY 1982, six HSS-2B helicopters in FY 1983 and one S-61A helicopter in FY 1983.

CSO: 4120

MILITARY

GSDF SENDING MISSION TO U.S. TO SURVEY AH-1S

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 8, 9

[Text] The GSDF has been authorized under the FY 1981 budget to send two officials to the United States for a survey on its introduction of the Bell AH-1S antitank helicopter. The two GSDF officials will discuss cost for introduction of the AH-1S, Japan's possible license production and other matters with the US Army and Bell Helicopter Textron, the maker of the AH-1S.

The Japanese Defense Agency (JDA) is expected to prepare its final policy on the introduction of the antitank helicopter by the end of March or FY 1980 in a bid to start AH-1S procurement in FY 1982. The GSDF itself has already worked out a program for AH-1S deployment on the basis of its evaluation of two imported AH-1S helicopters. The evaluation results have indicated the AH-1S is the most suitable for the GSDF's antitank weapons system. The GSDF apparently intends to set up 3.5 AH-1S squadrons with 56 aircraft.

The AH-1S is the only pending item in aircraft procurement projects of the FY 1980-84 Medium Term Defense Program (MTDP). The GSDF has long hoped to deploy antitank helicopters, the only deficiency in its overall weapons system.

CSO: 4120

MSDF TO OPERATE UP-2Js FOR TRAINING

Tokyo JPS AVIATION REPORT-WEEKLY in English 28 Jan 81 p 9

[Text]

The JDA has authorized the MSDF to start operation of the first and second UP-2J aircraft for fleets' firing and electronic warfare training at the 51st Air Patrol Squadron in Shimofusa. The UP-2J is a modified version of the P-2J antisubmarine warfare aircraft to replace the S2F-1U utility aircraft.

The MSDF intends to deploy a total of four UP-2Js. The first UP-2J has been equipped with a missile seeker simulator and the second with a sleeve-type target towing system. Besides these equipment, a sleeve-type target towing system and a target drone launching system will be mounted on the first one by FY 1982, and a jamming system and a drone launching system on the second by FY 1983.

The third and fourth UP-2Js are designed to collect electronic warfare data. The third will be equipped with data collecting systems from the current fiscal year to FY 1981. Although modification work on the fourth had been planned for FY 1982-83, a request for procurement of its data collecting systems in FY 1981 has been disapproved. The same request will be made for FY 1982 with the modification put off until FY 1983.

CSO: 4120

JSDF SH-X SURVEY TEAM TO VISIT U.S., BRITAIN AROUND MAY

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 p 8

[Text]

The MSDF is likely to send a team to the United States and Britain around May to survey candidates for the SH-X antisubmarine helicopter replacement for the HSS-2B. In the FY 1981 budget, the service is authorized to dispatch two men abroad for 21 days for that purpose.

The JDA's FY 1980-84 Medium Term Defense Program envisages procurement of two SH-X helicopters for tests, which the MSDF intends to request in FY 1982. Deployment of the new shipborne antisubmarine helicopter is planned for the early 1990s.

The most promising candidate is the U.S. Navy/Sikorsky SH-60B. Since another candidate, the British Westland WG-34, is still under development, the MSDF is expected to request two SH-60Bs as green aircraft in FY 1982.

CSO: 4120

JDA FY 1981 SERVICE PLAN

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 pp 3-8

[Text] The following is a summary of the JDA's service plan for FY 1981 (April 1981-March 1982) based on the government's FY 1981 budget drafted toward the end of 1980:

1. Organization

(1) Reorganization

*GSDF

(a) Part of a communications orientation unit in Kurihama and a communications inspection unit in Ichigaya will form an electronics unit in Higashi Chitose to strengthen GSDF electronic warfare capability.

(b) The 305th Security Company will be organized for the Northeastern Army.

(c) A service unit will be established for a new garrison in Ebino.

(d) A transportation section will replace the Transportation Office at the GSDF Equipment Department for more efficient transport operations.

*MSDF

(a) Units will be reorganized for the FY '77 funded DD Hatsuyuki, FY '78 funded SS Setoshio, FY '79 funded MSC and other ships.

(b) The Fifth Fleet Air Wing will be set up in Okinawa to replace the Okinawa Air Squadron.

(c) An Iwojima Search and Rescue Unit will be established with two S-61A helicopters.

(d) An electronic warfare support unit will be organized in Yokosuka as part of the MSDF electronic warfare support setup.

(e) A medical unit will be set up for the Ominato MSDF District.

*ASDF

(a) An ad hoc F-15 squadron will be set up in the third quarter of FY 1981 with eight F-15s delivered. The 306th Squadron with F-4EJs will be established at Komatsu Air Base in the first quarter to replace the 205th F-104J squadron. Two new F-4EJs will enter service in the year.

(b) An air training squadron under the Air Defense Command will be organized at Tsuiki Air Base with five T-2s and two T-33As for training of combat squadrons.

(c) An air safety control unit will be organized at Tachikawa Air Base.

(d) A communications maintenance unit will be set up at the Central Air Communications Group.

(2) Personnel

The SDF personnel will be increased by 996 persons--661 for the MSDF, 319 for the ASDF and 16 for the Joint Staff Countil. New fixed personnel figures will be 44,558 for the MSDF, 46,523 for the ASDF and 99 for the Joint Staff Countil. Reserve SDF members will be increased by 1,000 to 42,600.

2. Intelligence & Communications

(1) Defense attaches in foreign countries will be increased by two to promote collection of foreign military information. The two will be a GSDF officer for Aust[illegible] and an ASDF officer for China.

(2) Efforts will be continued to promote air and maritime patrols around Japan with ships and aircraft.

(3) Communications equipment, including the defense microwave circuit, will be improved to increase command/communications capability, while construction of central command systems will start with completion planned for the end of FY 1982.

3. Operational Affairs

(1) MSDF: Management of torpedoes and mines will be improved under a FY 1980-85 plan to promote the MSDF's readiness. Research on very long-wave transmitting stations will be done for smoother communications with submarines.

(2) ASDF: Research on a new BADGE air defense system will be continued and its operational scheme prepared.

(3) All three SDF services: Improvement of air base defense capability by procurement of aircraft shelters and runway repair materials as well as Tan-SAM short-range and portable surface-to-air missiles; promotion of air traffic safety measures by procurement of control and meteorological observation equipment and improvement of aircraft components; improvement of electronic warfare capability by continued collection, analysis and evaluation of electronic warfare data; continued research on defense operations and Japan-U.S. defense cooperation.

4. Personnel & Medical Affairs

Efforts will be continued to delay the retirement of SDF personnel, and action will be taken to promote recruiting. Health promotion measures will also be taken. Recruitment will comprise about 16,200 Private Second Class GSDF men, about 2,400 MSDF Seamen and about 2,300 ASDF Third Class Airmen.

5. Training

Acquisition and procurement of training ammunition and facilities will be promoted. Major training programs are as follows:

(1) GSDF: Regional exercises (inclusive of northern mechanized unit exercises), transfer exercises, and an annual Hawk firing exercise in the United States.

(2) MSDF: Maritime defense exercises, dispatch of training ships to Southeast Asia and Oceania, and dispatch of ships and aircraft to Hawaii for training.

(3) ASDF: Extensive air defense exercises, an annual Nike firing practice in the United States, air space coordination in Northern and Western Japan, and research on the operation of the ACMR/I training/evaluation system.

(4) All three SDF services: Tri-service joint exercises, Japan-U.S. joint exercises, and improvement of a training setup around Iwojima.

6. Equipment

*GSDF

(a) Ground equipment acquisition: 5,100 Model 64 rifles, 51 Model 62 machine guns, 38 Model 74 vehicle-mounted machine guns, 188 84mm recoilless guns, eight Model 64 MAT (antitank missile) launchers, 65 Model 64 81mm mortars, 26 Model 75 155mm self-propelled howitzers, eight Model 75 130mm self-propelled SSRs, three Model 75 self-propelled wind measuring systems, one 35mm L-90 machine gun set, 60 Model 74 tanks, nine Model 73 armored personnel carriers, three Model 78 tank recovering vehicles, 22 Model 78 snow vehicles, and two Model 70 self-propelled pontoon bridges.

(b) Ground equipment procurement: 1,800 new pistols, 5,000 Model 64 rifles, 51 Model 62 machine guns, 38 Model 74 vehicle-mounted machine guns, 219 84mm recoilless guns, nine Model 79 Ju-MAT antitank missile sets, 44 Model 64 81mm mortars, 30 Model 75 155mm self-propelled howitzers, six 203mm self-propelled howitzers, eight Model 75 130mm self-propelled SSRs, 72 Model 74 tanks, nine Model 73 APCs, three Model 78 tank recovering vehicles, 23 Model 78 snow vehicles, and three Model 70 self-propelled pontoon bridges.

(c) Aircraft acquisition: 20 aircraft--10 OH-6D observation helicopters, five HU-1H utility helicopters, one V-107A search/rescue helicopter, two LR-1 liaison/reconnaissance aircraft, and one TL-1 trainer.

(d) Aircraft procurement: 14 aircraft--eight OH-6Ds, five HU-1Hs, and one LR-1.

(e) Surface-to-air missiles: The Second AA Group in Matsudo will be equipped with improved Hawk missiles, while six Tan-SAM sets and 14 portable SAM sets will be procured.

*MSDF

(a) Ships entering service: five ships (7,080 tons)--one FY '77 funded DD, one FY '78 funded SS, two FY '79 funded MSCs, and one FY '79 funded AGS.

(b) Shipbuilding: seven ships (16,980 tons)--one 4,500-ton DDG, two 2,900-ton DDs, one 2,200-ton SS, two 440-ton MSCs, and one 3,600-ton AS. Modernization of the Takatsuki DDA will start.

(c) Aircraft acquisition: 16 aircraft--three P-3C anti-submarine warfare aircraft, one US-1 search/rescue flyingboat, two TC-90 instrument flight trainers, eight HSS-2B anti-submarine helicopters, and two S-61A helicopters.

(d) Aircraft procurement: 12 aircraft--one KM-2 trainer, four TC-90s, six HSS-2Bs, and one S-61A.

*ASDF

(a) Aircraft acquisition: 41 aircraft--eight F-15J/DJ fighters, two F-4EJ fighters, two F-1 support fighters, one C-1 transport, 14 T-2 trainers, 11 T-3 trainers, one MU-2 search/rescue aircraft, and two V-107A search/rescue helicopters.

(b) Aircraft procurement: 17 aircraft--two F-1s, four E-2C airborne early warning aircraft, two C-130H transports, six T-2s, one MU-2, and two V-107As.

(c) Surface-to-air missiles: Two Tan-SAM and six portable SAM sets will be procured.

*All three SDF services

Ammunition, torpedoes, mines, missiles and other operational equipment will be increased to improve war capability.

7. Countermeasures

Efforts will be made to improve facilities for re-organization and introduction of new equipment, powder magazines, torpedo and mine stocks, ports and harbors, and other buildings.

8. R&D

(1) Research and development will continue on electronic switching systems, high-speed homing torpedoes, control-configured vehicle (CCV) aircraft and other equipment, while research and development will start on the MT-X intermediate trainer and other equipment.

(2) Modification of F-4EJ fighters will start to lengthen their service and increase their performance.

9. Others

(1) Personnel and facilities will be prepared for promotion of secrecy maintenance.

(2) Environmental protection will be promoted with improved boilers, water treatment facilities, silencers and other equipment.

(3) Preparation of aircraft, vehicles and other equipment for rescue operations will be promoted.

(4) Publicity activities will be stepped up to have the people understand and acknowledge national defense problems.

CSO: 4120

JDA TO ORDER 51 ENGINES IN FY '81

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 p 2, 3

[Text]

The Japanese Defense Agency (JDA) is expected to order 51 aircraft engines from domestic manufacturers in FY 1981, when it will procure 43 aircraft--14 for the Ground Self-Defense Force (GSDF), 12 for the Maritime Self-Defense Force (MSDF) and 17 for the Air Self-Defense Force (ASDF).

Orders for 43 engines, including nine spares, will be placed with Ishikawajima-Harima Heavy Industries Co. (IHI). They are seven F100s (spares for ASDF F-15Js), 16 TF40 Adour engines (four for ASDF F-1s and 12 for T-2s), one T56 as a spare for an MSDF P-3C, 14 T58s (12 for MSDF HSS-2Bs and two for S-61As), and five CT58s (four for ASDF V-107As and one spare). Kawasaki Heavy Industries Ltd. (KHI) will be awarded orders for eight T53-13Bs (five for GSDF HU-1Hs and three spares). In addition, the JDA's Technical R&D Institute (TR&DI) will order four prototype small-turbofan engines for tests from IHI.

From overseas in FY 1981, the JDA will procure 250-C20Bs for eight GSDF OH-6D observation helicopters, TPE331s for one GSDF LR-1 liaison/reconnaissance aircraft and one ASDF MU-2 search/rescue aircraft, PT-6s for four MSDF TC-90 instrument flight trainers, one IGSO-480 for one MSDF KM-2 trainer, and T56-425 spares for ASDF E-2C airborne early warning aircraft.

CSO: 4120

JDA TO LAUNCH 7-YEAR MT-X PROGRAM IN FY 1981

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 p 9

[Text] The JDA will launch a seven-year program for developing the MT-X intermediate jet trainer in FY 1981 as originally planned by the Technical R&D Institute (TR&DI) now that funds, though somewhat scaled down, have been approved for a basic MT-X design in the next fiscal year. Immediately after the start, the JDA will select a prime contractor for the program perhaps this summer.

The MT-X is designed to replace both the T-33A and T-1A/B trainers. In a bid to develop the new trainer before retirement of T-33As starting in FY 1988, the JDA had requested ¥2,398 million for the basic design in FY 1981. The funds were cut by about ¥800 million to ¥1,596 million at intra-government budget negotiations. The approved funds comprise ¥329 million in FY 1981 and ¥1,267 million in follow-on disbursements.

The disapproved ¥800 million, which covers part of the basic design coinciding with a detailed design starting in the latter half of FY 1982, will be requested again together with funds for the detailed design for FY 1982. The detailed design cost is estimated at ¥5,000 million. Thus, the JDA's budget request regarding the program for FY 1982 will total ¥5,700 million to ¥5,800 million. The whole cost for the MT-X program is estimated at ¥37,200 million in FY 1980 prices.

The MT-X program will comprise the basic design in FY 1981 and 1982, the detailed design in FY 1982 and 1983, fabrication of prototypes from FY 1983 to 1985 and flight tests and other development tests from FY 1985 to 1987.

CSO: 4120

SIX PROJECTS FOR GUIDED WEAPONS APPROVED

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 p 10

[Text] The government has approved ¥3,460 million for the TR&DI's six research and development projects for guided weapons systems in the FY 1981 budget, although the TR&DI had requested ¥6,011 million for eight projects.

Two disapproved projects are the ¥2,500 million dogfight missile development and the ¥250 million test image homing system fabrication. The dogfight missile project has been shelved apparently as a result of coordination of the TR&DI and ASDF budget requests, in which priority has been given to procurement of the C-130H transport and the MT-X intermediate jet trainer project. In the budget request for FY 1982, the project will be incorporated as a priority item. The six approved projects are as follows:

(1) Chu-MAT antitank missile: ¥80 million (¥90 million requested). The TR&DI adopted an electromagnetic gyro using the proportional lead navigation formula, as proposed by Kawasaki Heavy Industries (KHI) and Nippon Electric Co. (NEC), for the Chu-MAT in April 1980. In FY 1981, a test warhead will be fabricated. Fabrication of the whole system is planned for FY 1982. The missile is designed to become operational in FY 1987.

(2) SSM antiship guided missile: ¥430 million (¥440 million requested). The missile is a modified version of the ASDF ASM-1 antiship missile. In FY 1981, an inertial navigation system and an engine section will be fabricated.

(3) Portable SAM: ¥1,790 million (¥2,070 million requested). Research on the image homing SAM started in FY 1977. Fabrication of a test booster is planned for FY 1981.

(4) HTPB propellant: ¥110 million as requested. Final fabrication of the high-performance propellant is planned for FY 1981.

(5) Precision guidance simulator: ¥790 million (¥920 million requested).

(6) Additional physical simulation system: ¥260 million (¥270 million requested). The system for evaluating radio homing performance will be annexed to the existing simulator at the TR&DI's Third R&D Center.

CSO: 4120

GSDF, MSDF TO PROCURE FIVE CHUKAR II DRONES IN FY 1981

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 pp 8,9

[Text] The GSDF and MSDF will procure five Northrop Chukar II target drones for missile firing exercises in FY 1981, while Nippon Electric Co. (NEC) will conclude a contract with Northrop possibly this summer on future license production of the drones.

The GSDF has been allowed to purchase one Chukar II drone for firing exercises of the Tan-SAM short-range surface-to-air missile to be procured from this fiscal year (two had been requested). The GSDF and TR&DI have already imported six Chukar II drones--two each in FY 1977, 1978 and 1979--for tests of the Tan-SAM. Of them, four have been used for Tan-SAM technical and operational tests.

The MSDF has been authorized to procure four of the drones for exercises of the Sea Sparrow SAM, which will be mounted on a FY '76 funded DDH, and DDs funded in FY 1977 and after. Its original request was for seven.

The two services plan to procure more than 10 Chukar II drones per year from FY 1982, enabling NEC to start license production.

CSO: 4120

MILITARY

DDA FRAM PROGRAM TO START IN FY 1981

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 9, 10

[Text] The MSDF will start a five-year fleet rehabilitation and modernization (FRAM) program for the 3,000-ton Takatsuki DDA destroyer in FY 1981 as the government has approved four-year disbursement of ¥9,600 million in the FY 1981 budget for purchase of new weapons systems to be installed in the ship.

The new weapons systems are the Harpoon surface-to-surface missile, 20mm CIWS and electronic systems. Modification work on the Takatsuki will be carried from FY 1983 to 1985 after a basic modification plan and a basic design are drafted in FY 1982. Modification funds totaling some ¥5,000 million to ¥6,000 million will be incorporated into the FY 1982 budget request. Thus, the Takatsuki FRAM program is estimated to cost a total of ¥15,000 million. The Takatsuki is the first DDA built in FY 1963. Following the start of its FRAM program in FY 1981, similar programs for the Kikuzuki, Mochizuki and Nagatsuki DDAs are expected to begin in FY 1982 or after.

The FRAM program is designed to increase ships' anti-aircraft and antiship capability and to lengthen their service life by modernization of components, including use of missiles. In the DDAs, two Harpoon SSMs, a Sea Sparrow SAM and a 20mm CIWS will replace one currently installed five-inch gun and drone antisubmarine helicopters (DASH). Data processing systems and masker antinoise systems will also be newly mounted. As to the VDS-mounted Takatsuki and Kikuzuki, the MSDF is considering installing the VDS-TASS sensor.

CSO: 4120

CONTRACTORS SELECTED FOR RJ500 FUEL-CONTROL SYSTEM

Tokyo JPE AVIATION REPORT-WEEKLY in English 4 Feb 81 p 2

[Text]

British and American engine component manufacturers have been named contractors for development of the fuel-control system of the Rolls-Royce/Japanese RJ500 aircraft engine, according to sources close to Rolls-Royce and Japanese Aero Engines Ltd. which is engaged in the RJ500 program. These contractors are Hamilton Standard of the United States for the hydraulic mechanical control, Dowty Fuel Systems of Britain for the fuel pump and Dowty-Smiths Industries Control of the same country for the electronic controls. Rolls-Royce will be responsible for management of the total system, they say.

The fuel control system is the most important component of the engine. In selecting contractors, Rolls-Royce and Japanese Aero Engines Ltd. prudently studied proposals of various American and European manufacturers. When the fuel-control system development setup is ready, the RJ500 program will be advanced smoothly. The system will be completed by March 1982.

Originally, the Japanese had been assigned to the fuel-control system development. But fans and flight tests have been added to Japan's business and the fuel-control system has been transferred to Rolls-Royce's task.

CSO: 4120

SUMITOMO TO PRODUCE HEAT EXCHANGERS FOR RJ 500 ENGINES

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 p 3

[Text] Sumitomo Precision Products Co., Ltd., has been awarded a contract for the production of heat exchangers for the RJ500 engine now being developed for medium-size passenger aircraft by Rolls-Royce Limited and Japanese engine manufacturers, the Japanese company announced last week.

Rolls-Royce and Japanese Aero Engines Limited, the joint venture between the British company and three Japanese aircraft engine manufacturers (i.e., IHI, KHI and MHI) has selected the Sumitomo's lightweight and compact product through international bidding held in London recently.

Sumitomo will deliver prototype units toward the end of 1981. It plans to produce 20 RJ500 heat exchangers per month during the peak period. One unit is estimated to cost approximately ¥1 million.

This is the first time a Japanese-designed heat exchanger was selected for a new aero engine program, Sumitomo said.

CSO: 4120

ECONOMIC

SUNDSTRAND TO HOLD SYMPOSIUM FOR JAPANESE INDUSTRY

Tokyo JPE AVIATION REPORT-WEEKLY in English 28 Jan 81 pp 2,3

[Text] Sundstrand Corporation will hold a two-day symposium on advanced systems for the Japanese aerospace industry on January 29 and 30 at the United States Trade Center in the World Import Mart, Tokyo. The seminar is supported by Nissho-Iwai Aerospace, Teijin Seiki and Sony Corporation.

The company will be represented at the symposium by Jay Fernandes (Vice President & General Manager - Sundstrand Aviation Mechanical), Richard Borzilleri (VP & Gen. Mgr. - Sundstrand Aviation Electrical Power), Clifford N. Hall (VP & Gen. Mgr. - Sundstrand Energy Systems), William R. Kopp (Group VP - Sundstrand Data Control Group), R. H. Ilgenfritz, (VP - Avionic Systems, S.D.C. Group), J. Douglas Cline (VP & Gen. Mgr. - Global Navigation), John B. Landstrom (VP - Trans Com, S.D.C. Group), B.W. Kittle (Group VP - Sundstrand Advanced Technology Group), K.A. Groff (VP - Administration, Sundstrand Corp.) and about 20 other company experts and engineers.

The programs which will be presented at the symposium will include: electrical generating systems for both commercial and military aircraft, factors that affect the application and role of microprocessors in electrical power generating system design, and trends in 400 Hz power generation (by Sundstrand Aviation Electric Power); engine starting systems and accessory drives, actuation systems, F404 power level control, emergency and supplementary power, fluid pumping airframe components, fluid pumping engine equipment, air-cycle environmental control units, and avionics cooling and refrigeration (by Sundstrand Aviation Mechanical); airborne recorders, head-up displays (HUD) and processing technology and terrain avoidance systems - military, and airborne recorders, HUD, terrain avoidance, weight and balance, navigation systems, instrumentation

products and passenger entertainment systems - commercial (by Sundstrand Data Control Inc.); and organic ranking cycle bottoming systems, missile power units, open-cycle underwater propulsion equipment and space power systems (by Sundstrand Energy Systems).

Approximately 400 representatives from leading Japanese aerospace and electronic firms as well as government related agencies will attend the Sundstrand symposium, according to a Nissho-Iwai spokesman.

CSO: 4120

BRIEFS

CONSUMER SPENDING RATE--Tokyo 18 Feb KYODO --Growth in consumer spending considerably slowed down in the October-December period from the preceding quarter, according to an official report. The Economic Planning Agency compiled the report based on a nationwide random sampling of 5,837 average households last December. The survey showed the average expenditure per household during the fourth quarter of last year totaled yen 864,000. This represented a 4.3 percent rise over the year before, off steeply from a 6.6 percent increase in the preceding quarter. For the current January-March quarter, a 5.7 percent increase was projected. The per-household net income averaged yen 1,155,000 in the October-December quarter. This was only a 4.6 percent rise over the year-before-level, compared with a 4.8 percent increase in the preceding quarter. For the current January-March period, the average net income was expected to rise 4.7 percent on the year-to-year basis. During the fourth quarter of 1980, expenditures for durable consumption goods declined 1.5 percent, compared with a 9.3 percent rise in the preceding quarter. Spending on clothing, foods and entertainment was also sluggish. A 53.7 percent of all the households expected domestic business conditions to worsen in the coming year. This compared with 45.3 percent in the previous survey. Meanwhile, 37 percent foresaw their own living standards worsening, up from 33.2 percent. [Text] [OW180441 Tokyo KYODO in English 0214 GMT 18 Feb 81 OW]

JANUARY MAN-MADE FIBER PRODUCTION--Tokyo 12 Feb KYODO--Japanese production of man-made fibers in January totaled 146,452 tons, down 1.8 percent from last December, the Japan Chemical Fibres Association said Thursday. Output of synthetic fibers last month amounted to 111,708 tons, down 2.3 percent from the preceding month, and that of cellulosic fibers came to 34,718 tons, down 0.4 percent. By item, production of polyester in the synthetic fiber category stood at 51,272 tons, down 2.1 percent from last December; acryl, 28,267 tons, down 1.3 percent; nylon, 25,068 tons, down 3 percent, and vinylon, 3,373 tons, down 2.4 percent. Output of rayon yarn in the cellulosic fiber category amounted to 4,884 tons, up 0.1 percent from last December; rayon staple, 21,719 tons, levelled off; acetate yarn, 2,420 tons, down 1.2 percent; acetate staple, 2,985 tons, down 3.6 percent, and cupra yarn, 1,863 tons, up 0.2 percent. [Text] [OW12054 [as printed] Tokyo KYODO in English 0538 GMT 12 Feb 81 OW]

TARIFF ESCAPE CLAUSE--Tokyo 13 Feb KYODO--The Japanese Government will add an escape clause soon in its preferential tariff system, which it hopes will work toward an eventual reduction of Japanese imports from medially-developed nations. In order to put it into force on 1 April, the government plans to submit a bill to the present Diet session to revise the provisional law on tariff measures. Government sources said the 10-year preferential duties agreement, signed with 146 nations, would be renewed on 1 April for extension of another 10 years. The sources said the move is apparently aimed at checking a steep increase in imports from medially-developed nations like South Korea, Taiwan and Hong Kong. They said the escape clause would enable the government to exclude some products from particular nations from the list of items under the application of preferential treatment. However, the move is expected to create a furor among medially-developed nations, they said. [Text] [Tokyo KYODO in English 0638 GMT 12 Feb 81 OW]

JANUARY TRADE DEFICIT--Tokyo Feb 12 KYODO--Japan suffered a 2,477 million trade deficit on a customs clearance basis last month, the Finance Ministry announced Thursday. The preliminary figure compared with a dollar 1,483 million surplus in December and a dollar 3,462 million shortfall a year before. Exports were up 35.4 percent over a year earlier at dollar 9,447 million last month and imports rose 14.2 percent to total dollar 11,924 million. Exports were calculated on a free on board (fob) basis and imports on a cost, insurance and freight (cif) basis. In yen terms, January exports were up 16.1 percent at yen 1,923 billion. Imports fell 2 percent to yen 2,433 billion. The resultant yen 510 billion shortfall compared with a yen 825 billion deficit a year before. [Text] [Tokyo KYODO in English 0638 GMT 12 Feb 81 OW]

JANUARY STEEL PRODUCTION DOWNTURN--Tokyo 13 Feb KYODO--Japan's crude steel production in January hit a 34-month low of 8.32 million metric tons, the Japan Iron and Steel Federation said Friday. The steel production, being edged down since last autumn because of sagging demand, was the lowest since March 1978 when steel output was 8.27 million tons. A federation official said the mills are cutting down their production in the hope that their, and wholesalers', stocks of steel products will be reduced to an appropriate level by the end of next month. The official said it would apparently take some more time before they can finish inventory adjustments. [Text] [Tokyo KYODO in English 0255 GMT 13 Feb 81 OW]

OIL STOCKPILE COMPANY--Tokyo 6 Feb KYODO--A new oil stockpiling company will be set up in Tokyo on 27 February, Japan National Oil Corp. said Friday. The firm, named Tomakomai-Tobu Oil Storage Co., will build oil tanks with a storage capacity of 6.2 million kiloliters near Tomakomai, southern Hokkaido by the end of fiscal 1985. Construction costs will reach yen 140 billion. The oil storage company, with a paid-up capital of yen 2.5 billion, will be owned 70 percent by Japan National Oil, 15 percent by Idemitsu Kosan Co., 2 percent by General Sekiyu K.K., 1 percent by Asia Oil Company and the balance by banks, insurance firms and electric power firms. Japan National Oil Corp. is a state-run investment firm for oil projects. [Text] [Tokyo KYODO in English 0226 GMT 6 Feb 81 OW]

FERTILIZER TO PRC--Tokyo 4 Feb KYODO--The Japan Ammonium Sulphate Export Company has won a dollar 137 million fertilizer order from China for shipments in the latter half (January-June) of the 1980 fertilizer year, it was announced Wednesday. The company has contracted to supply China with 200,000 tons of ammonium sulphate and 400,000 tons of urea at a 5 percent higher price than that agreed on for shipments in the first half (July to December) of the fertilizer year. The newly contracted price is well below the prevailing domestic price, which is 30 percent higher than the price agreed on with China for shipments in July-December 1980. The deal has been clinched on a dollar-priced and dollar-payment basis. The new deal brings the total exports of fertilizers to China in the present fertilizer year to 380,000 tons of ammonium sulphate and 720,000 tons of urea, making a total of 1,964,000 tons in terms of ammonium sulphate, down 10.8 percent from the previous year. The total export value comes to dollar 245 million. The decline in the Chinese order is due to the deterioration of China's financial position, the company said. [Text] [OW061221 Tokyo KYODO in English 1218 GMT 4 Feb 81 OW]

CSO: 4120

GOVERNMENT TO EMPHASIZE RESEARCH ON DECOMMISSIONING NUCLEAR REACTORS

Tokyo DENKI SHIMBUN in Japanese 18 Dec 80 p 3

[Text] On Decommissioning Nuclear Reactors; Trend Is for Serious Deliberations; Japan AEC: Technical Committee to Investigate from Next Spring; Science and Technology Agency: To Request Long Range Budget

The problem of decommissioning nuclear reactors shows a trend toward serious discussions. Late last month, the Japan AEC decided to establish a technical committee on nuclear reactor decommissioning countermeasures, selected committee members on the 19th, and it plans to begin investigations early next year. In anticipation of the reactor decommissioning problem materializing 10 to 15 years hence, the aim of the technical committee is to select the various problems related to reactor decommissioning, then deliberate on the basic issues of reactor decommissioning countermeasures, on a comprehensive research and development plan, etc., and then to compile a report by August of next year.

On the other hand, the Science and Technology Agency has requested 650 million yen as the commission fee from the power source special committee's diverse account for the next fiscal year in developing reactor decommissioning technologies. Development of essential technologies, such as the development of the radioactivity inventory evaluation technology, will be started beginning the next fiscal year and during the latter half, the large-scale long range plan is to actually dismantle the Japan Power Demonstration Reactors [JPDR] of the Japan Atomic Energy Research Institute [JAERI]. Even the deliberations on developing reactor decommissioning technologies by the technical committee will be discussed with emphasis on this plan, and the aim is to compile and authorize the details of this plan.

The Science and Technology Agency plan is divided into the First and Second Phases. The First Phase covers the development of essential technologies, such as (1) system engineering for reactor decommissioning, (2) radioactivity inventory evaluation technology, (3) technology on the non-destructive measuring of the piping system for internal radioactivity and contamination, (4) dismantling engineering method and dismantled machinery/equipment, (5) decontamination technology related to reactor decommissioning, (6) dismantling and waste matter processing technology, (7) transportation and removal system for dismantled waste matter and machinery/equipment, (8) dismantled waste matter disposal method, (9)

radiation management technology during dismantling and (10) remote control technology for reactor decommissioning. The plan is to begin with technologies (6) to (8) from JFY-1982 on.

It is felt that 3 or 4 years will be needed to complete the development of these essential technologies. These results will be influenced by the dismantling plan of the JPDR and the safety evaluation. Upon completion of the dismantling plan, the dismantling notice is served based on the laws regulating nuclear reactors, etc.; at the same time, dismantling preparations such as the production of machinery, equipment and apparatus to be dismantled, the building of decontamination facilities and disposal equipment, the construction of remote control apparatus, etc., will be made and after decontamination before dismantling the JPDRs, the First Phase will be completed.

The Second Phase includes practical tests for dismantling the JPDRs, and with the First Phase taking 6 years and the practical tests, 4 years, a total of about 10 years is forecasted for the entire process. The cost is expected to total around 20 billion yen. The objective is for engineering research and development on decommissioning reactors through execution of this plan, and the objective is to serve the decommissioning of commercial reactors which may reach actualization in 10 to 15 years.

The experience in Japan on decommissioning reactors has been limited to the JRR-1 and the small-size critical apparatus at the JAERI. According to the Science and Technology Agency commissioned survey undertaken by the JAERI, the United States has the best performance record and since 1960 it has decommissioned five nuclear reactors which have been approved for power generation use, four demonstration reactors and six test reactors; besides these reactors, about 50 research reactors have been decommissioned. The majority of the research reactors has been dismantled, but the bulk of the commercial reactors and demonstration reactors has been sealed control or shielded isolation.

Recently, even in the United States, it is reported that the prevailing opinion is preference for dismantling over sealing or shielded isolation. In France, since 1965, the leading critical assembly units, research reactors and power reactors, totalling eight units, have been in permanent disuse with varied decommissioning methods.

On the other hand, Japan has to decide on its course of action hereafter, such as on decommissioning methods, but because the country is generally narrow and reutilization of the vacated land is necessary, it is said that the dismantling and removal method is the most realistic. Even with the JPDRs, the plan is to dismantle and even level off the vacated land. Also it appears that the course of action for processing/disposal of the dismantled waste matter will be an important topic hereafter for the technical committee.

The JPDRs have stopped operating since March 1976, but since its first power generation activity in 1963, they have contributed to the cultivation of technicians through the BWR characteristic test and the fuel/material irradiation test as well as through construction and operation; and to the growth of commercial reactors.

Once again activity will ensue with the big topic of decommissioning. Already in the various advanced countries, research has been speeded up with emphasis on design, materials, structure, etc., on the subject of decommissioning in the future, and the deliberations and engineering research and development by the technical committee hereafter will be watched.

9510
CSO: 4105

PROPOSED BIOTECHNOLOGY RESEARCH, DEVELOPMENT PROGRAM OUTLINED

Tokyo KOGYO GIJUTSU in Japanese Vol 21, No 12 Dec 1980 pp 22-24

[Article by Y. Tsukamoto, Basic Chemicals Section, Basic Industries Bureau, Ministry of International Trade and Industry]

[Excerpt] R&D Promotion Measures

1. Re: Promotion structure

Biotechnology research and development are to be promoted under the Next Generation Basic Industrial Technology R&D System (tentative name) proposed by the Ministry of International Trade and Industry as the new JFY 1981 policy.

The Next Generation Basic Industrial Technology R&D System (tentative name) is a system to make use of the private sector's vitality and potential to nurture basic technologies such as biotechnology, new materials, new function elements, etc, that are indispensable for the establishment of the next generation, whose blossoming is anticipated in the 90's, to aim for a technological nation in the 90's. As shown in the outline of the system (Table 1), the plan is to invest approximately 120 billion yen in 10 years. (An inside figure of 31 billion yen is proposed for biotechnology for the 10 years.)

Table 1 Outline of the Next Generation Basic Industrial Technology R&D System (tentative name)

1. Establish in JFY 1981.
   1981 budget request: 5,183 million yen

2. Major projects to be adopted by the System are as follows:

   (1) New materials (fine ceramics, functional macromolecular materials, metallic materials, compound materials)

   (2) Biotechnology (bioreactor (industrial application of bioreactions), mass cell culture techniques, genetic recombination application techniques, cell fusion application techniques)

(3) New function elements (three-dimensional circuit elements, biochemical detection elements, etc)

3. The period of research and development is expected to be 5-10 years for each subject, and the total necessary fund is estimated to be approximately 120 billion yen for the 10-year period.

4. The method of research and development to be adopted are development by commission to private firms as well as the introduction of parallel development methods and stepwise target-setting methods in order to carry out systematic and efficient development.

5. The goal is to create an R&D structure by cooperation of industry, academic circles, and the government (Experimental Stations).

2. Substance of Research and Development

In biotechnology research and development under the Next Generation Basic Industrial Technology R&D System, 1 billion 310 million yen is requested as the 1981 budgetary measure (total plan: 10-year, 31 billion yen) to promote research and development by selecting subjects that are far-reaching and highly innovative from the viewpoint of future industrialization regarding the establishment of four major technologies of bioreactors (industrial application of bioreactions), mass cell culture techniques, genetic recombination application techniques, and cell fusion application techniques. Examples of specific subjects are as follows: (Fig. 3).

(1) Bioreactors (industrial application technique of bioreactions)

Research and development will proceed centered around oxidation reactions which are most frequently used in the chemical industry (Example: oxidation of olefin). The goal is to strive for energy-saving of 1/2 to 2/3 compared to existing processes.

The specific substance of research and development include a search for micro-organisms having enzymes that efficiently promote the target reaction and the development of fixation techniques for the enzyme and microorganisms after which trial calculations of the bioreactor are evaluated. In addition, concurrent studies on bioreactors using an enzyme model catalyst will be conducted as a parallel development in this subject.

Period for research and development is 8 years; required R&D fund for the initial year is 370 million yen, and a total R&D fund of approximately 11.1 billion yen is projected.

(2) Mass cell culture techniques

Research and development will proceed centered around the elucidation of cell growth promotion factors in bovine fetal serum which are indispensable for animal cell culture and the development of substitutes, as well as establishing high efficiency culture techniques with high cell culture density.

The period of research and development is 7 years; the required R&D fund for the initial year is 310 million yen, and a total R&D fund of approximately 5.4 billion yen is projected.

(3) Genetic recombination application techniques

Industrial production processes shall be established for enzymes (oxidase, protease, etc) having a heat-resistant property that can be applied in industrial processes, etc by using this technique.

Specific substances for research and development include a search for the gene that orders the production of heat-resistant enzymes to be obtained, insertion of this gene into E. coli, etc, and the production of the heat-resistant enzyme by E. coli, etc.

The period of research and development is 10 years; the required R&D fund for the initial year is 470 million yen, and a total R&D fund of approximately 10.1 billion yen is projected.

Note) The enzymes have been used in the past in the food sector, but they have short life due to heat lability and are limited in areas of application.

(4) Cell fusion application techniques

Industrial production processes shall be established by applying this technique for monoclonal antibodies which have prospects for use as raw materials for industrial reagents and pharmaceuticals.

Specific substance for research and development include the selection of two kinds of cells suitable to obtain the target product (monoclonal antibody) efficiently, and to establish the optimum conditions to accomplish cell fusion.

The period of research and development is 10 years, and the required R&D fund for the initial year is 108 million yen, and a total R&D fund of 4.5 billion yen is projected.

Note) Monoclonal antibodies are taken from blood at present. Therefore, it is difficult to obtain them in quantity, and they cannot be used effectively under this circumstance.

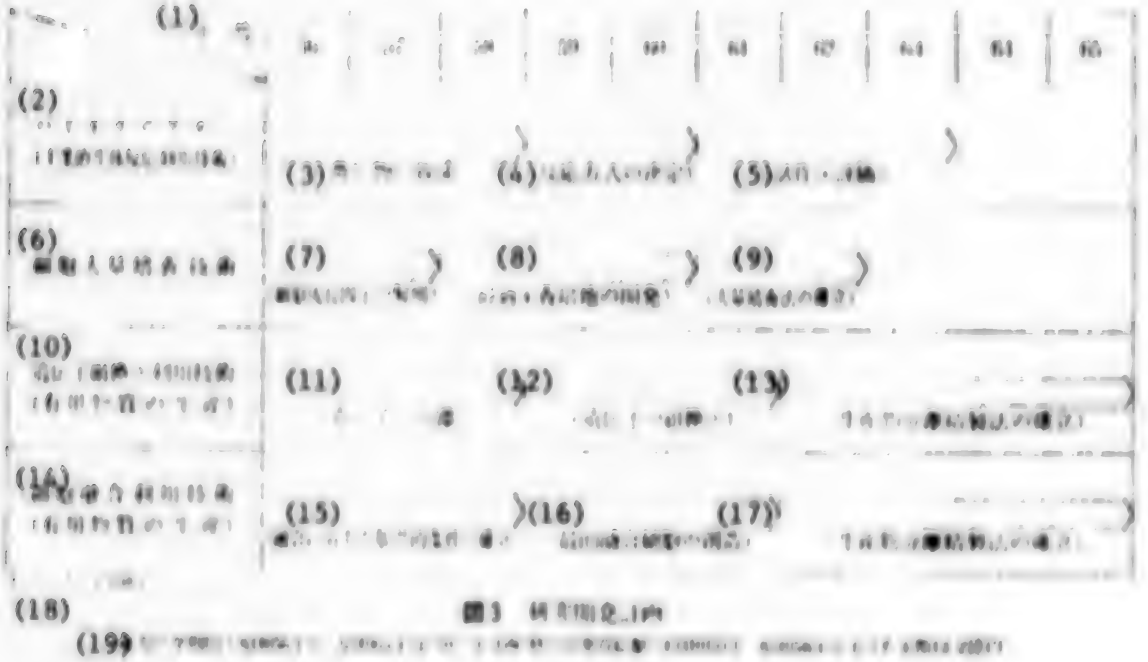

Fig. 3 R&D Program

KEY:

(1) JFY 1981-1990
(2) bioreactors (industrial application technique of bioreactions)
(3) (search for microorganisms)
(4) determination of reaction formulae
(5) (trial manufacturing, evaluation)
(6) mass cell culture techniques
(7) (elucidation of cell growth factors)
(8) (development of optimum nutrient medium)
(9) (establishing mass culture techniques)
(10) genetic recombination application techniques (production of useful substances)
(11) (separation of genes)
(12) (genetic recombination)
(13) (establishing products separation and purification methods)
(14) cell fusion application techniques (production of useful substances)
(15) (establishing basic conditions related to fusion)
(16) (creating the optimal fusion cells)
(17) (establishing product separation and purification methods)
(18) Note: Major research items are in parentheses.
(19) Period of research and development: 1981-1990 (10-year program); Total R&D expense: approx. 31 billion yen; JFY 1981 budget request: 1.32 billion yen.

7722
CSO: 8129/0553

FIBER LASER PLATES FOR NEW IMAGERY PROCESSING DEVELOPED

Tokyo SHINGIJUTSU KAIHATSU REPOTO in Japanese Summer Issue 1980 pp 40-45

[Article by Junya Seko and Akira Sasamori of the Research Institute of Electronics, Department of Science and Engineering, Waseda University: "Fiber Laser Plate New Image Processing Device"]

[Text] I. Introduction

The development of a parallel processing system for parallel processing in a two-dimensional manner of figures as they are has become an extremely important subject to the area of image information treatment. This situation is the result of the treatment method presently used involving the use of computers in a treatment mode in which the image is first converted into a time related signal and then changed to an input signal through an A-D converter after which complex computations are performed within the computer as the result of which the processing requires considerable time. Fundamentally, the conversion of information which has two-dimensional spread into a one-dimensional time-wise information is an irrational step which is a situation difficult to avoid because the electronic computer which represents the top achievement of electronics is based on a time-wise treatment.

In contrast to the above situation, image processing modes employing parallel processing have recently been developed in the area of optic information processing. Computations such as Fourier conversion, differentiation, and convolution with light have made possible extremely great speeds which is probably a notable achievement. On the other hand, all of these operations are analog computations which make precision on problem. At the same time, the use of lenses makes the situation where the equipment becomes extremely massive unavoidable. This is why the early development of a digital mode using small elements has become a pressing problem in the area of optic information processing.

In another direction, pattern recognition information technology has become particularly popular during the past few years, and the development of elements which can now treat material which heretofore had been handled through the software end by the hardware itself through the use of elements which can reduce images of varying degree of gradation into simply the two values of black and white and devices which possess a much greater degree of treatment capability have enabled the speedup and higher precision of the treatment process.

The element which was devised and developed with the capability to respond to these needs is the fiber laser plate (FLP). The FLP is a multiple capability parallel image information processing device which processes images in two component manner and also handles a high degree of processing by parallel treatment mode instantaneously.

2. Makeup of FLP

As its name implies, the fiber laser plate possesses a plate type construction in which fiber lasers are deployed in parallel manner. A laser glass (neodynium glass was used in the test fabrication) is the core around which is placed very fine hairlike and fiberous glass laser coated with glass with lower index of refraction than the core (these were 80 μm diameter in this test version), and about 2,500 strands of these fibers are bundled into a 5 mm diameter and about 8-10 mm thick circular post shaped plate structure with mirrors placed at both end surfaces to serve as the laser resonators. The mirror at the input side readily transmits incident light and reflects the laser light which is generated. The mirror on the output side conversely reflects incident light very readily and transmits several percent of the generated laser light using aluminum which has wavelength selectivity.

Up till now the laser has been utilized as a device which generates but a single beam, but the FLP has 2,500 strands of fibers deployed every one of which can exploit the functions of a laser. When yellow light (wavelength 5,800 A) which is the absorption wavelength of the laser glass which makes up FLP is incident upon the input end surface through the input image, the fiber lasers in the region corresponding to the image begin to oscillate, and a laser image is broadcast from the output side at the near infrared wavelength of 1.06 μm.

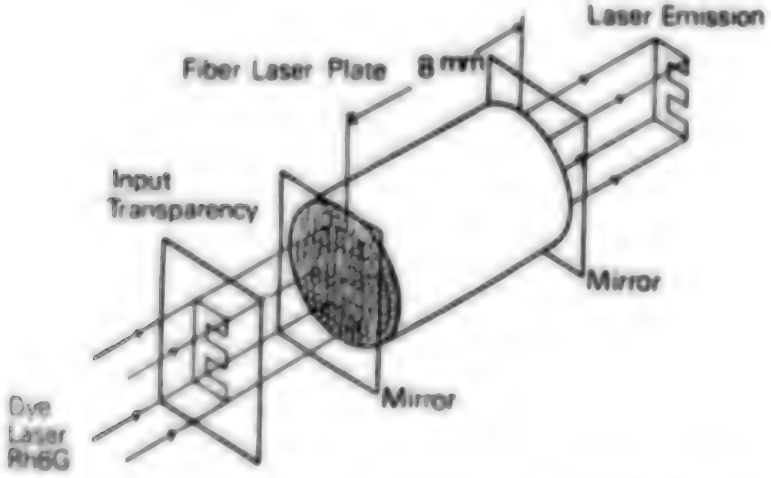

Figure 1. Diagram Explaining Principle of FLP

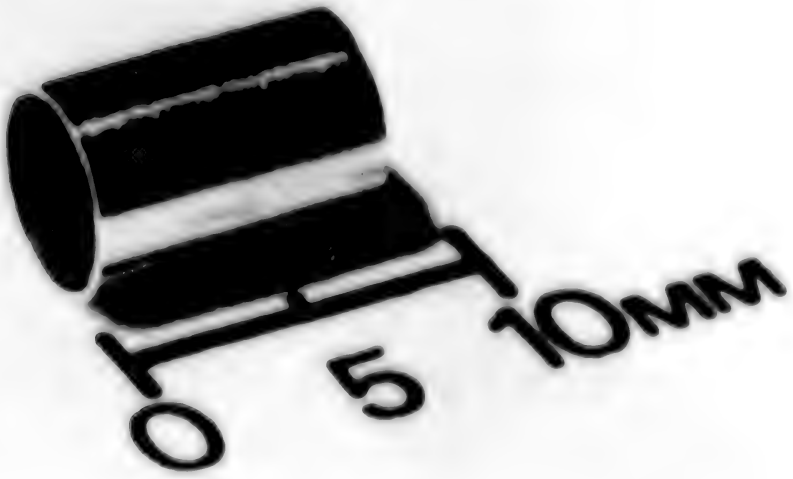

Figure 2. External View of FLP

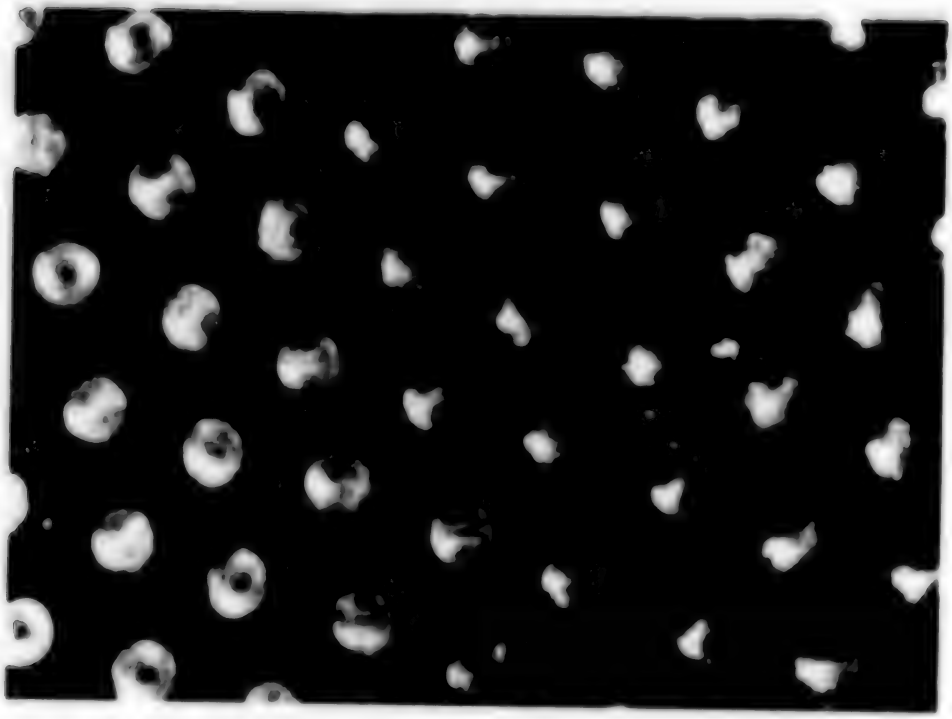

Figure 3. Microphotograph of End Surface of FLP
The lightest area are the cores and the
faintly dark surrounding areas are the crud

3. Giving the Image Two Values

The capability of FLP to give an image two values utilizes the threshold properties of laser oscillation. Generally speaking, the laser will not cause any oscillations to occur when the input energy is lower than its energy (threshold energy), and there is essentially no light discharge. On the other hand, when the energy of the incident light is energy at the level of the threshold value, light is suddenly emitted with large energy which is the threshold property this laser possesses. Now when a series of images with varying degrees of lightness and darkness is incident on the FLP, the fiber lasers which are at the sections corresponding to the points of the light and dark images of varying gradations which are brighter than the threshold value each begins to oscillate and laser light is discharged from the exit end. The points at which the brightness is below the threshold level do not cause the fiber corresponding lasers not to oscillate thereby making up the dark areas. The image at the output side is completely a two-value affair of light and dark with the threshold value as the boundary.

At this time, the rise-up value of the output at the threshold value greatly contributes to influence the two-value forming capability, but FLP has a large value of which is a term used in photographic technology to describe this property of the order of several dozens such that nearly everything is close to switching, and it may be said that it is provided with superior two value forming capability.

There is need to set the threshold value for two-value formation at any desired level according to the image at hand, and this is conducted by superimposing a bias light on FLP. By superimposing a bias light on the input signal image, the FLP threshold value as seen from the FLP varies with the bias light volume. Since the constitutive images in FLP are fiberous in nature, it becomes possible to effectively utilize the open windows of the fiber (this is determined by the difference in indices of refraction of core and fiber). In other words, it should be possible to simultaneously input both the signal and the bias light from different angles efficiently (any angle in the range that will enable entrance through the open window).

By using the two-value forming capability which is inherent to FLP, the image can be converted to two-value images in nsec-usec speed.

4. Application to Image Processing

Pattern recognition processes include pretreatments such as detection of image, recording, readout, and extraction of characteristics along with recognition, and FLP has the possibility of calculating the stages such as simple characteristics extraction in parallel manner by high speed computations.

When a certain figure such as a triangular figure is inputted into FLP after which a second image which is a triangular figure of slightly larger size is inputted, the initial triangular figure does not oscillate because of the refractory period involved, and oscillation corresponding to the difference between the two triangular figures is all which takes place such that the contour alone should be outputted. This is a contour extraction capability of the figure utilizing different treatment,

and it should also be possible to perform computations on sums, products, and negative-positive conversions.

At the same time, there is also the possibility of spatial modulation of the image by the coupling effect between neighboring fibers during FLP.

It is possible to speed up image processing by utilizing this type of capability of FLP for preprocessing.

5. Post Statements

It is still only a short time since the start of FLP development, and we are, experimentally speaking, still in the stage of verifying the two-value forming capability, but high levels of processing capabilities of the type mentioned before can be anticipated in the future.

The computer which represents the greatest contribution of electronics has deeply penetrated our daily lives and has given us a number of blessings, however, most people do recognize that the computer is not a panacea for everything. Simple figures which can be recognized by infants and even animals lower than man will take an electronic computer considerable time before it can recognize them. The high degree of the visual information treatment capability of a living body is an astounding thing, but we can gain a number of hints from this high level capability. Although the machanism of a body's visual information processing has not yet been adequately explained, the parallel nature of the optic nerve bundles and the refractory properties of the neurons are well known. It may be said that the idea of image processing which we propose had its start which was hinted by the living body. When one considers the miracle of the living body, the FLP represents but a very, very low order of processing capability, and we will be fortunate if we can make small step-by-step advances through greater understanding of the highest capabilities of the living body.

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MITI EMPHASIZES NUCLEAR POWER PLANT RELIABILITY TESTS

Tokyo DENKI SHIMBUN in Japanese 23 Dec 80 p 3

[Text] Forecasted for greater activity in JFY-1981 are the demonstration tests on the reliability of nuclear power generation facilities for which MITI has been conducting actual surveys with the selection of key test questions in order to demonstrate the safety and reliability of nuclear power generation machinery and equipment. The demonstration tests on the reliability of steam generators for which these questionnaire categories were applied for the first time in JFY-1975 were completed in JFY-1980, and the government will make a comprehensive evaluation, on the basis of the report compiled by the commissioned agency, in autumn of 1981; and it will explain the countermeasure methods to confront the troubles arising from such problems as the pin hole, and their effectiveness to the many concerned in the industry, and improved results can be expected. Demonstration tests on the reliability of electrical instruments are forecasted to be first given in JFY-1981 and MITI would "like to clarify the problem areas as much as possible through these various tests and would like to gain the understanding of a large segment of the people on the reliability, etc., of nuclear power." The Heat Engine for Power Generation Association and the Nuclear Power Engineering Test Center have been commissioned and are conducting the tests.

The categories and substance of [illegible]I-sponsored Demonstration Tests on the Reliability of Nuclear Power Generation Facilities which consist of (land calculations?) by the Power Source Special Assembly are as follows: (1) Time or period of the demonstration test, (2) total cost of the test, (3) amount of funds requested in the JFY-1981 budget, (4) a summary of the test and (5) principal tests planned in JFY-1981.

Demonstration Test on the Reliability of the Steam Generator (Commission Fee)

(1) JFY-1975 to -1980, (2) about 6.2 billion yen, (3) none, (4) regarding the discharge of the pin hole, etc., from the small tubes which are a part of the steam generator that comprises the principal apparatus of the Pressurized Water Reactor [PWR] type power generation facility, the demonstration test identifies the causes of the discharge, effectiveness of the countermeasure procedures, etc., and (5) completion in JFY-1980.

Demonstration Test on the Reliability of the Valves (Commission Fee)

(1) JFY-1976 to -1983, (2) about 5.7 billion yen, (3) 730 million yen, (4) to demonstrate the safety and reliability of the principal valves, numbering about 70 types from among several thousand valves used in the nuclear power generation facility by testing them under operating conditions which are equal to or more severe than the actual apparatus and (5) the environmental tests, functional efficiency and leakage tests, safety valve and escape valve tests will be performed as a continuation from JFY-1980.

Demonstration Test on the Reliability of the Fuel Assembly (Commission Fee)

(1) JFY-1976 to -1984, (2) about 8.8 billion yen, (3) 1 billion yen, (4) to demonstrate the reliability of the fuel assembly of the Boiling Water Reactor [BWR] and the PWR by confirming through the actual apparatus the appropriateness of design and production and the soundness of the irradiation time based on the consistent demonstration data obtained from "production stage to irradiation stage and then to the testing stage," and by confirming through use of the out-pile loop the various properties which are difficult to obtain from the actual apparatus and (5) tests during and after irradiation from the BWR type fuel and the PWR type fuel will be conducted as a continuation from JFY-1980. Also the BWR loop testing apparatus for the maximum heat load test (out-loop test) of the fuel assembly will be constructed.

Demonstration Test on the Reliability of the Welded Sections, Heat Affected Sections and Other Sections (Commission Fee)

(1) From JFY-1977 to -1983, (2) about 10.7 billion yen, (3) 2.01 billion yen, (4) to demonstrate the identification of the causes of the minute cracks which occur in a section of the support pins and flexible pins of the reactor control rod and leading pipes which constitute a part of the welded sections, heat affected sections and other sections of the core spray system piping, recycling bypass pipes, etc., of the BWR type power generation facility as well as a part of the incore structure of the PWR type power generation facility; the effectiveness of the countermeasure procedures, etc., along with the soundness of the in-service inspection [ISI] method and (5) with the BWR, acceleration tests will be conducted as a continuation from JFY-1980 and integrated imitation tests will be begun. The testing apparatus for the BWR type will all be completed and various tests will be conducted. The ISI demonstration test will include conducting the manual flaw detection test and constructing the prototype and other parts for the automatic flaw detection test.

Demonstration Test on the Reliability of the Pumps (Commission Fee)

(1) JFY-1977 to -1983, (2) about 4.9 billion yen, (3) 1.24 billion yen, (4) to demonstrate the retention of the safety and reliability of the recycling pumps of the BWR type power generation facility and the primary cooling pumps of the PWR type power generation facility which are especially important from among the myriad equipment, by testing them under operating conditions which are equal to or more severe than the actual apparatus and (5) for the demonstration test on the

reliability of the recirculating pumps, the test apparatus and prototype will be completed and preparations will be readied for the testing. Also the construction of the prototype for the primary cooling pumps will be a continuation from JFY-1980.

Demonstration Test on the Reliability of Earthquakeproofing the Nuclear Power Generation Facility (Commission Fee)

(1) JFY-1980 to -1987, (2) about 25 billion yen, (3) 1.45 billion yen, (4) to demonstrate the earthquakeproofing safety and reliability of the important large-size facilities of a nuclear power plant, by first constructing the prototype test unit (reactor container, primary cooling apparatus, etc.) at the size of the original or magnitude as close to the original, and then testing it on a large-size high performance vibrating table and (5) the design and manufacture of the prototype of the reactor container for the PWR type power generation facility and the recycling system piping for the BWR type power generation facility will be a continuation from JFY-1980. Also the design of the prototype for the PWR type in-pile structure will be started.

Demonstration Test on the Reliability of the Electric Instruments (Commission Fee)

(1) JFY-1981 to -1986, (2) about 3.5 billion yen, (3) 50 million yen, (4) to demonstrate the safety and reliability of electrical instruments used in the nuclear power station and considered important from the standpoint of safety, by testing them under operating conditions equal to or more severe than the actual apparatus and (5) to undertake basic designs for the demonstration tests.

Demonstration Test on the Reliability of Earthquakeproofing of the Nuclear Power Generation Facility (Subsidy)

(1) JFY-1975 to -1981, (2) about 14.7 billion yen, (3) 1.82 billion yen, (4) in order to demonstrate the soundness and reliability of the important machinery and equipment in a nuclear power generation facility during an earthquake, construct a large-size high performance vibrating table apparatus which can produce simulated earthquake tremors and (5) machinery, piping, wiring, etc., will be installed at the site and the installation of all the machinery will be completed after testing to confirm the operations, as a continuation from JFY-1980. Also preparations for the construction of all buildings and the installation of instrument data processing apparatus, etc., will be completed.

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EXPERIMENTS ON FOUR-LEGGED WALKING ROBOTS DETAILED

Tokyo SHINGIJUTSU KAIHATSU REPOTO in Japanese Summer Issue 1980 pp 1-14

[Article by Shigeo Hirose of the Department of Mechanical and Physical Engineering, School of Engineering, Tokyo Institute of Technology]

[Text] 1. Introduction

It has been pointed out that the walking movement which is a model translational function of animals is an exploitation of the unique capability of conforming to the terrain which is a property not shared by artificial man-made moving mechanisms, and it has now been more than 20 years since research and development was initiated on a practical walking mechanism utilizing this type of movement. During this period, there have been the flow of research [1-4] in which leg movements were created through phase differences between a single power source and mechanical elements such as a link cam which enable fixed-type walking but which were intended to mimic as closely as possible the walking gait of living bodies in a type of effort that was common during the earliest days, research on piloted type walking mechanism in which a master slave type mechanism is used to expand the movements of the human upper and lower limbs and thereby duplicate walking [5], and research directed at realizing a high degree of autonomic control and conformity with the terrain capability [6,9,12,13] by the coordinated control of the overall actuator of a walking body with various degrees of freedom in joint construction. On the other hand, while it is the present situation that this research has provided bioengineering insight into the walking movements and elucidated a number of problem areas on control when attempts at duplicating these movements are artificially made, it is still not possible to produce a practical mechanism which can perform the true goal of walking over uneven ground.

The author renewed his thoughts on such a walking mechanism and conducted a number of preliminary experiments as a result of which he was able to show that one of the major problem areas which made difficult the practical development of a walking mechanism was the configuration of the walking leg and the associated mechanism [10], and he proposed the three-degree freedom pentagraph (hereafter abbreviated 3 FP mechanism) as one of the means to resolve this problem [11].

This report will discuss the general features of this 3 FP limb mechanism, touch on the makeup of the walking mechanism control facility of this limb mechanism particularly on the various problems on system makeup of the most basic operating control system, and present the results of a number of walking control tests which were conducted on walking mechanical models test produced to demonstrate the effectiveness of this mode.

2. Number of Legs, Formation, and Structure

When the makeup of a walking mechanism is considered, the establishment of the number of legs is one of the major problems. First of all, it is only natural that dynamically stable and statically stable walking will be the uppermost thought where controlability is concerned as the actual model is progressively developed. Such being the case, the number of legs should be greater than four. There have been test constructed to date four, six, and eight-legged walking machines among which the six-legged affair has been noted to show very great promise and has been the main figure in the research efforts [12,13]. This study, however, will select for consideration a four-legged model from the standpoint of simplicity of the overall walking mechanism and the height of the stacking load ratio. Furthermore, the static stability of a four-legged mechanism when compared to devices with five or more legs has the limitation of selection of but a single free leg, and this characterizes walking control problems which make necessary adequate predicting and intelligent walking capability to enable the maintenance of static stability while walking over uneven ground or when adapting to higher elevations. This is an interesting problem which should be taken up in the future.

In another direction, the author stated previously that as far as the shape of the leg was concerned, a curved leg such as that of insects would be more advantageous than the straight type leg characteristic of mammals for the following reasons [10].

(1) The center of gravity is lower during statically stable walking, and the stability can be maintained while lengthening the leg length as a result of which the walking speed of this walking mechanism and the relative accommodation to the terrain can be improved.

(2) Should the usual type motor be used as actuator for the mechanism, the energy efficiency during walking operations is somewhat better with insect type legs.

At the same time, the author also showed that walking movements through the rocking motion of multiple joint link mechanism will suffer in energy efficiency and potential energy efficiency compared to the wheel-type locomotion as long as the actuator is not devised to recover energy during a braking period. He also showed that the potential energy loss supporting such a self-esteemed product can be removed, and a 3-degree of freedom pentagraph mechanism (3 FP mechanism) for the leg as illustrated in Fig. 1 was proposed [11]. This mechanism in essence operates while separating the operating degrees of freedom of the legs of this walking mechanism into the gravity field direction and the direction perpendicular to the gravity field direction in order to prevent the potential energy loss which has to be expended to support the weight of the mechanism during horizontal translation.

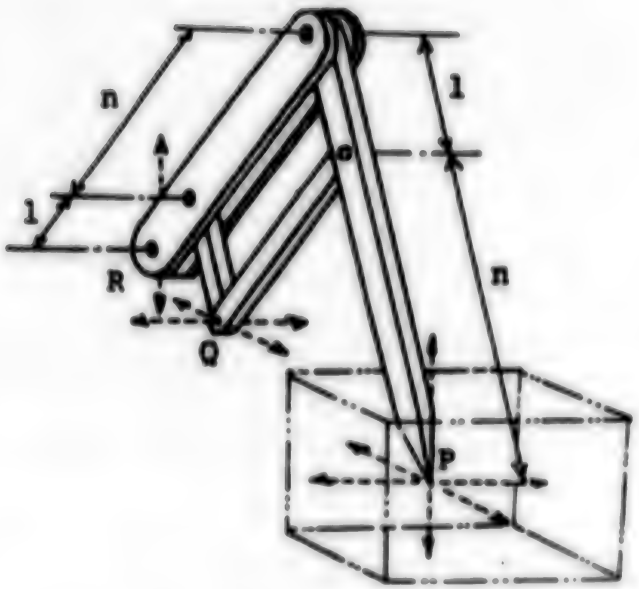

Figure 1. The Newly Proposed 3-Degrees of Freedom Pentagraph (3 FP) Mechanism for Walking (Point P is operated through a Triaxial Intersecting Coordinate System)

Since the walking mechanism considered in this research is made up of the construction described above, the control characteristics dependent upon this construction are such that the end of each of the legs can be controlled through direct (x,y,z) 3-dimensional rectangularly intersecting coordinates as a result of which the nonlinear type cooperative control including the trigonometric functions between actuators which were necessary to the joint type leg mechanisms of the past are no longer necessary. This innovation has made possible great simplification in the basic system of the walking mechanism and greatly improved the operating characteristics of the leg itself.

A conceptual diagram and the operable range of the leg of the walking mechanism under study are illustrated in Fig. 2.

3. Makeup of Walking Robot Total Control System

An operational control which can be thought to apply to a stacking together of a number of basic operations as is the case with walking probably will be a total control system with step-wise structure. This is a type of construction that is similar to the body movement control system of creatures such as men and one which has already been used in the past in control systems of manipulators with actuators and possessing multiple degrees of freedom and traveling mechanism. This control system is shown in Fig. 3.

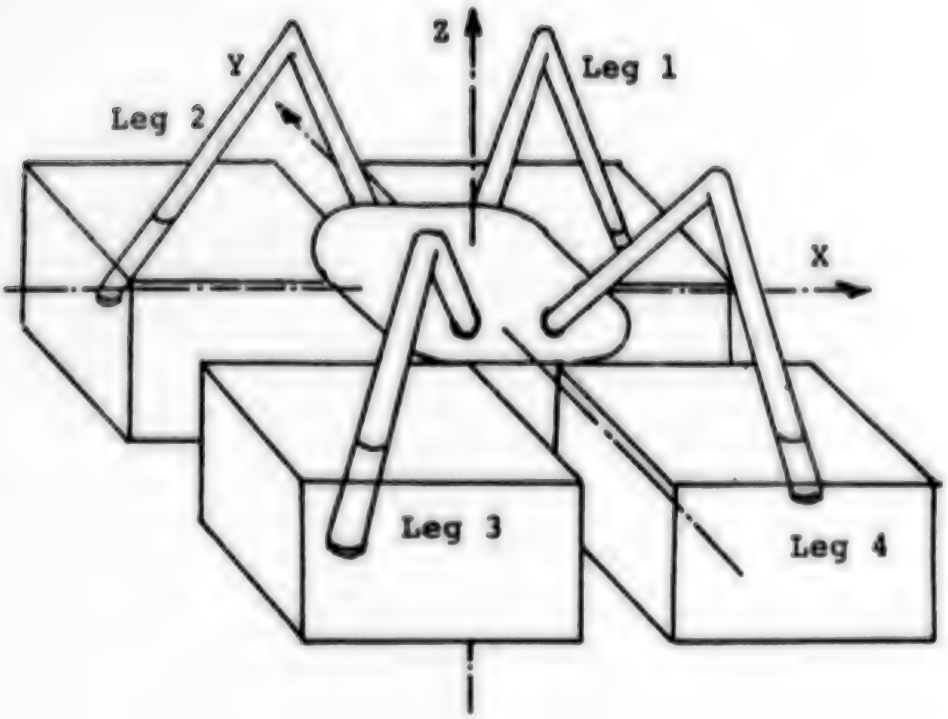

Figure 2. Body Coordinate System and Movable Range of Leg of the 4-Legged Walking Mechanism Considered in This Study

Control system A which is the control system of the highest degree of sophistication is one which makes strategic decisions such as the direction and speed of travel of the walking mechanism, and human involvement is usually employed. Problems of this level are not considered in this study. Control system B is one in which terrain information on the environment which needs to be covered is inputted beforehand as preliminary information to serve as auxiliary control aid. When this mechanism moves according to the translational strategy of the more sophisticated control system A, this system is of a level that it can make decisions as to ground contact points, order of contact, and translational guidelines for the body's center of gravity when traversing uneven ground and make the necessary orders. This is an important control system which requires adaptative intelligence. The walking mechanism which is the subject of this present study has not yet incorporated this visual system. The control level at this time is one in which a number of walking patterns are provided beforehand from which one is selected for the operation at hand.

Control system C is of a level at which a number of basic operational adjustments are made which are necessary for the walking movement's stable continuation. This system works continually throughout the walk and it generates control commands acting in reflexive manner on signals from various inner and outer fields and external detection groups to avoid contact with obstacles and maintain stable upright posture. Control system D is of the lowest level of

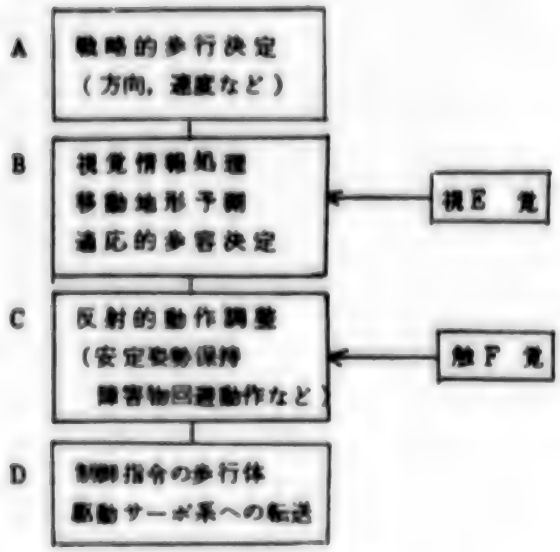

Figure 3. Step Layer Control System for Walking Mechanism

Key:
A. strategic walking decisions (direction, speed, etc)
B. visual information treatment, preliminary survey of terrain to be traversed, adaptative walking decisions
C. reflexive movement adjustments (maintaining stable attitude, avoiding obstacles, etc)
D. walking body responding to control command, transfer to driving servo system
E. visual
F. sensual

sophistication. After the upper level control systems have decided on the appropriate control commands and transfer commands have been issued after a suitable timing period, this command signal is issued as a target value to the actuator servo system of the walking mechanism main body, and the actual leg movement is initiated. When adapting the various information processing systems to the body systems [14], Fig. 3 A and B will correspond to new skin material, C to the cerebral peripheral system, and D to the functions of the brain stem and spinal cord.

In order to set up this type of step layer operational control, a number of modes come to mind, but the one which presently seems to offer the greatest practicality and highest developability is a microcomputer and its timer insert mode. A time chart which displays the step layer control state utilizing this timer insert mode in the walking mechanism which was actually test produced is shown in Fig. 4.

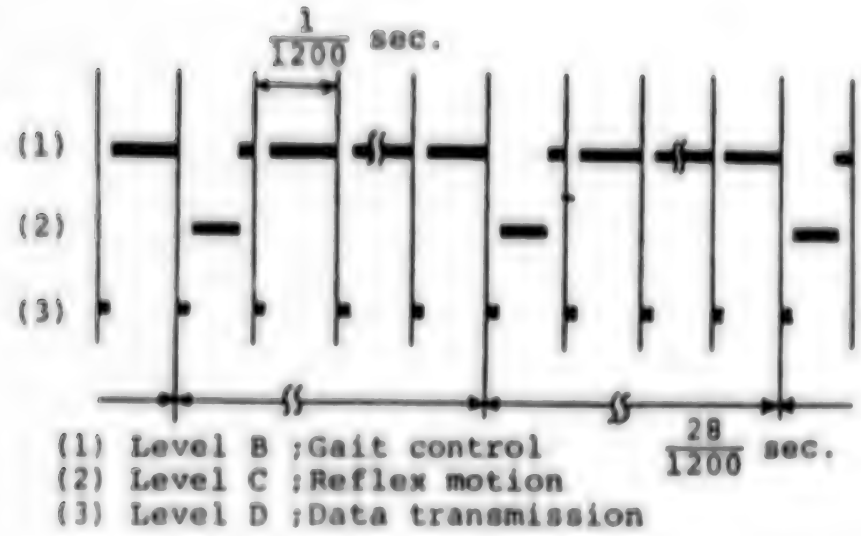

Figure 4. Processing of Timer Inserts for Step Layer Control

Some specific operations of the principal control levels are explained below.

3-1 Reflex Action Control System (Level C)

The following six reflex operations are necessary for a level C control system.

(1) Body center of gravity height adjustment--When the height in the z direction of the different legs differs when on uneven ground, the height of the center of gravity is constantly maintained at the average height within the operable range.

(2) Maintaining horizontal attitude of body--The body is always kept level through the use of a pendulum in the oil damper and its side section contact detector.

(3) Terrain seeking adjustment by 4-leg support phase--When the four-legged phase is over some type of uneven ground, adjustments are made so that all four legs are in continued support.

(4) Control of change in support leg phase--When a shift is made from the four leg support phase to three-legged support phase, designate which leg is to be free, and make adjustments for the z directional movement of the free leg when a return to a 4-legged support phase is made.

(5) Avoiding obstacles--When a free leg makes contact with an object

i) withdraw said free leg away from object,
ii) raise free leg to a set distance
iii) elevate center of gravity of body should the free leg get out of the operating range, and make a return to the initial operation. As a result of these actions, the reflex movement shown in Fig. 5 is performed.

(6) Adjustment of leg speed--This adjustment is made in accordance with the new target values given by the different actuators and the speed commands.

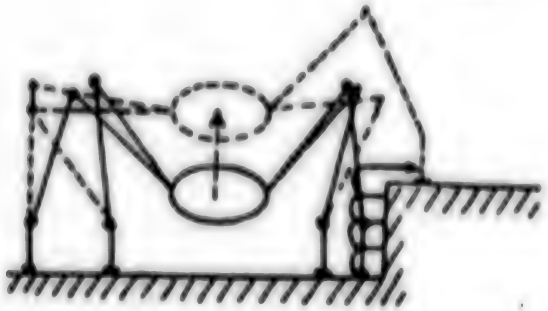

Figure 5. Trace of Obstacle Avoiding Movement

As illustrated in Fig. 4, one cycle of the various reflex actions is executed in 28/1200 sec so that each operation cycle requires 0.14 sec. As a result, these six different reflex actions are performed with seemingly simultaneous execution, and these operate synergistically to generate stable basic movement properties.

3-2 Walking Control System (Level B)

As described above, basic reflex control operations of Level C which is of a lower level than B is a step layer control system which at first glance appears to function independently so that when the walking control of "B" is considered, these basic adjustment operations can be disregarded and only factors such as the stability of the geometric positions of the legs are considered in the calculations and commands are issued for transmission to the servo system.

It is possible to freely go into model crawling movement, sidewise movement, and backward movement.

In addition, change in direction control can be effected with no slips. The following control principle is involved. When the x,y coordinates of leg i are (x_i, y_i), the coordinates (x_i', y_i') after rotation through the infinitesimal angle $\Delta\theta$ about the center of gravity are

$$x_i' = C \cdot x_i - S y_i \qquad (1)$$

$$y_i' = S \cdot x_i + C y_i$$

We assume here that $C = \cos \Delta\theta$ and $S = \sin\Delta\theta$. Now if a change in this field to the θ direction is to be made, the target values in equation (1) are rewritten $N = \theta/\Delta\theta$ times for all the legs and these are repeatedly transmitted to the servo systems by which means a change in direction operation is completed.

When it is desired to continue walking but to change direction at angle θ and with a turning radius of R, the synthesis of the two movements of parallel movement and turning about the center of gravity is executed as illustrated in Fig. 7.

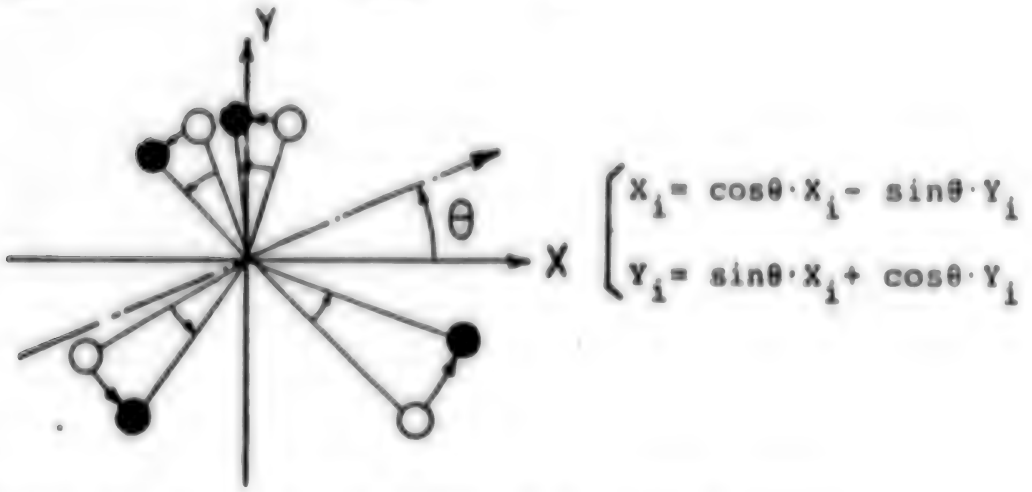

Figure 6. Translational Tracks of Leg Support Points during Change in Direction Movement in Field Direction

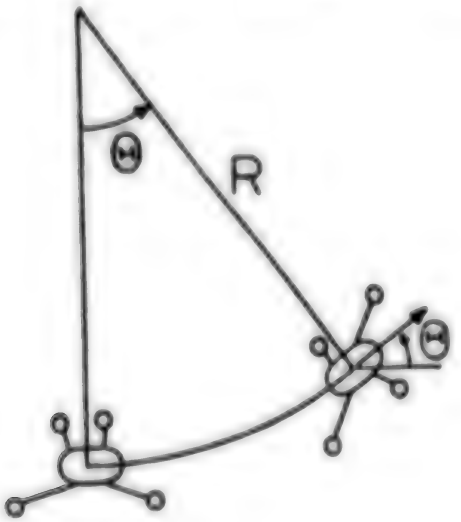

Figure 7. Translational Direction Conversion

4. Test Produced Walking Robot (PV II) and Its Walking Control Test

The discussion presented above on the leg mechanism and its control system was the basis for the test fabrication of a four-legged walking machine with 3 FP leg mechanism. This unit has been designated PV II (pedestrial vehicle Mark II) which is a successor to the Mark I [15]. The body dimensions are 480 x 340 x 240 in length x width x height; the overall leg length is 870, and total weight is 10 kg. The legs are provided with 3 FP mechanisms, and the ends of the feet are always maintained in vertical position by pulley mechanism. The movement degrees of freedom is 3 x 4 legs, and each is operated by a respective 2W DC motor.

The information detection sections are comprised of eight underfoot and side contact sensing gauges and an attitude detector. Information processing is centered on a 6800 series MPU with a 3 KB being used for control levels C and D and the smallest 2 KB for the walking control of level B. It may be said that this is a very simple control system.

An experiment displaying horizontal attitude retention function is shown in Fig. 8, and the attitude detector which makes possible this function is shown in Fig. 9. An example of control of height of the body center of gravity is shown in Fig. 10, and an overall view of the control facility is shown in Fig. 11. Crawl locomotion over flat ground by direct forward movement is illustrated in Fig. 12. This involves a translational speed of about an average of 2 cm/sec. This translational effect expends about 10 W power. It involves movement of about 2 kg load. Figure 12 (1) and (2) show the changes in field direction. The body weight is shifted somewhat in the forward-backward direction as rotation is performed through changing the direction of one leg at a time. A directional change of about 15° can be made in about 20 seconds. Taking a step up of any given width is illustrated in Fig. 13. In addition to these movements described above, changes in direction as illustrated in Fig. 7, ditch crossing, and sidewise walking were also tested.

5. Post Statements

This paper presented a discussion on a step layer control system for a walking mechanism exploiting the features of a 3 FP leg mechanism of the type illustrated in Fig. 1 along with the design principle, and tests on walking control of walking mechanism PV II which was test produced were also described. The results of the study demonstrated that walking mechanism PV II can traverse uneven terrain of ups and downs while maintaining horizontal body attitude without incurring slips of the legs as was the case of walking machines of the past [4] and can make changes in directions and display many other operational features. It also demonstrated sufficient load bearing capability with actuator of low power, and the control system is sufficiently miniaturized so that it can be carried aboard the mechanism. The realization of such results indicate that furthering developments in this walking mechanism in these directions should lead to the attainment of development of practical mechanisms in the near future.

The author takes this opportunity to thank Mr Hiroshi Sumihiro of this institute for his assistance in the test fabrication of the walking mechanism.

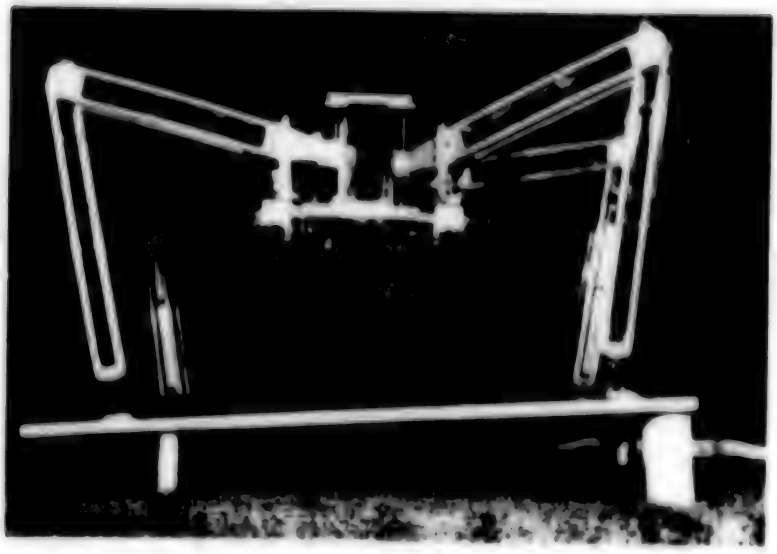

Figure 8. Reflex Action To Maintain Stereo Horizontal Attitude

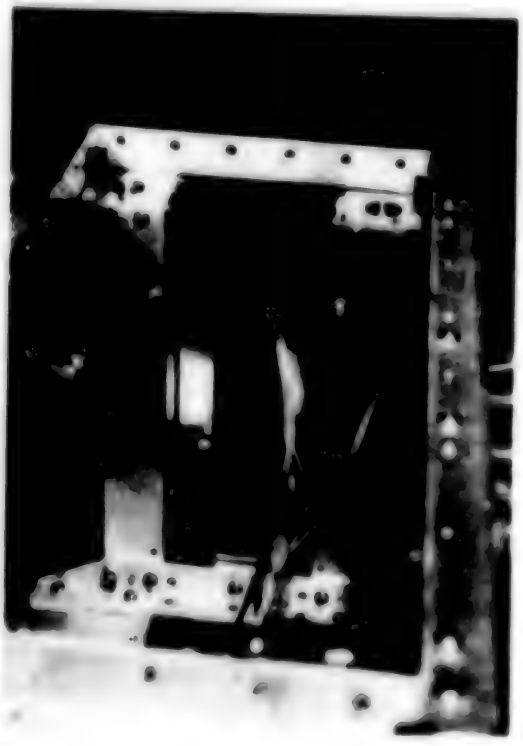

Figure 9. Attitude Detector Installed Within Body

Figure 10. Example of Body Height Control

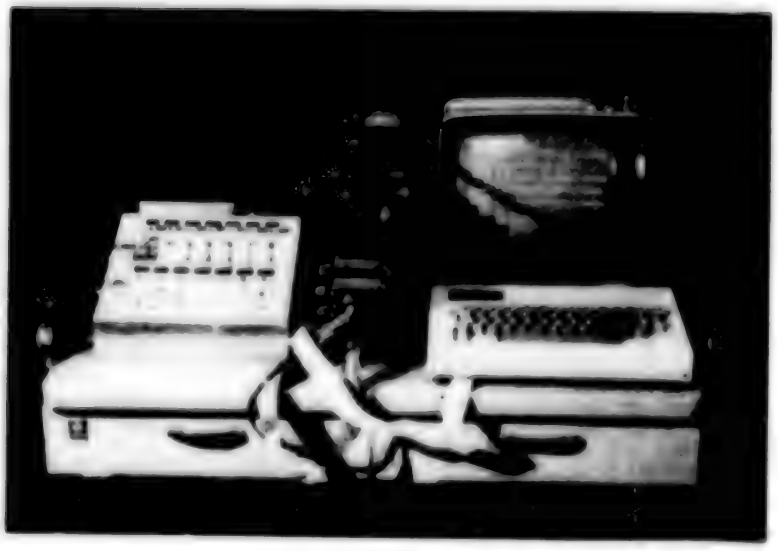

Figure 11. Overall View of Walking Mechanism Control Facility

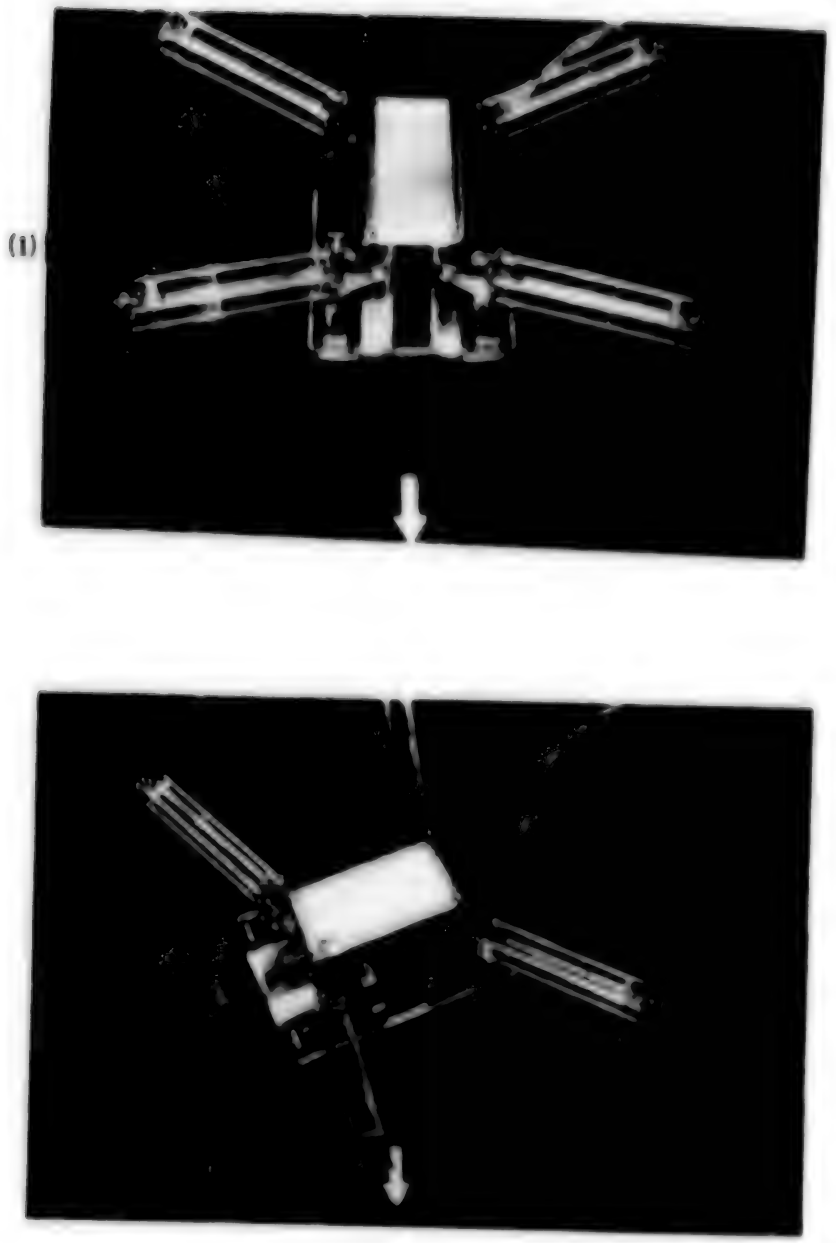

Figure 12. Example of Change in Field Direction
(A total of 4 changes in leg steps are performed between (1)-(2)

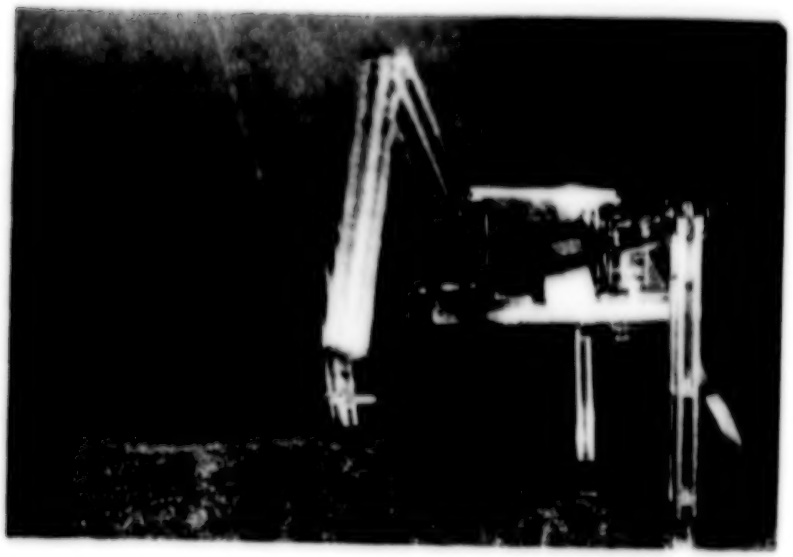

Figure 13. Example of Adaptive Walking Over Uneven Terrain

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